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Zoogeographic support for the Spanish Imperial Eagle as a distinct species

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Based mainly on morphological and behavioural criteria several past authors (e.g. Brehm 1861, Dresser 1873, Swan & Wetmore 1924, Hiraldo *et al.* 1976) have considered the Spanish Imperial Eagle *Aquila adalberti* Brehm 1861 as specifically distinct from its Eastern congener, *Aquila heliaca* (Savigny 1809). However, lacking more evidence supporting this distinction, most other authors (e.g. Hartert 1914, Vaurie 1965, Amadon 1982) divide the Imperial Eagle merely into 2 different subspecies, naming *Aquila heliaca heliaca* the Eastern and *Aquila heliaca adalberti* the Spanish Imperial Eagle. Most recently, Collar & Andrews (1988) in the *ICBP World Checklist of Threatened Birds* distinguish *adalberti* and *heliaca* specifically from each other.

At present the ranges of the eagles are separated by a wide gap in central Europe (see Cramp & Simmons 1980), and being allopatric, geographically isolated populations, the most important of the species criteria, i.e. the presence or absence of reproductive isolation (Mayr 1969a), cannot thus be used to determine their taxonomic status. The problem could be solved if it was possible to show that at some historical period, populations of both taxons occupied the same (sympatry) or contiguous (parapatry) ranges; in which case the presence of hybrids would prove a lack of reproductive isolation, while their absence would confirm the specific distinction (Mayr 1969b).

Gonzalez *et al.* (in press), revising the distribution of the Spanish Imperial Eagle since the 19th century, show that it has bred in the west of the Iberian Peninsula and in Morocco, while immatures during post-breeding dispersal have appeared at least in northeastern Spain, southern France and Libya. The purpose of this paper is to show that in that period the Eastern Imperial Eagle was breeding in the eastern Spanish Pyrenees,

France and Algeria, and that neither of the Imperial Eagles interbred at all.

Material and Methods

Information presented here comes mostly from the literature and from eggs and skins preserved in 13 museums we visited and 22 others which we contacted by letter (for details, see Gonzalez *et al.* in press). Data will be presented here by countries. When papers did not indicate the race of the cited Imperial Eagle, we used the description of the bird, if available, to assign it to one of them.

In the case of clutches of eggs preserved in museums, we were unable to distinguish between those of *heliaca* and *adalberti*, so usually we accepted the data on the label. Egg data slips from museum collections can be used to examine some aspects of reproductive biology of birds (McNair 1987) and their past distribution (Hiraldo *et al.* 1979, Hoffman & Collopy 1988); nevertheless, their reliability has been questioned (Storer 1930). Elsewhere, museum oological data have proved useful in understanding the past distribution and population changes of raptor species (Ratcliffe 1980, Bechard 1981). Suspect data, whether apparently falsified or not, are rare and usually detectable (McNair 1987).

Results

Spain

One clutch labelled as *heliaca* and collected by Hübner in Barcelona on 16 Apr 1902 (a date usual in *heliaca* but late for *adalberti*—Cramp & Simmons 1980) is in the Domplatz Museum (DDR). Vayreda y Vila (1883) recorded the occurrence of *Falco imperialis* in the Gerona province and described its plumage as uniform with large white spots on the scapulars, a pattern typical of *heliaca*; he also wrote of its breeding on cliffs, a nest site unknown for *adalberti* and rare, but used, by *heliaca* (Dandford 1878, Dementiev & Gladkov 1966). Fuset y Tubia (1913) identified an adult specimen preserved in a collection from Barcelona and collected in the same province, as *Aquila melanaetus*, Syn. *Aquila imperialis*, which from his description could be *Aquila heliaca*.

France

Before Brehm (1861) described *Aquila adalberti*, several authors reported *Aquila heliaca* in France. Crespon (1840) recorded the occurrence of Imperial Eagles in the Gard and Rhône departments, and Bailly (1853) said that Imperial Eagles which occurred in summer on Mt Cenis (Savoie) came from Piedmont (southern Alps). From their records it is not possible to decide which taxon is referred to.

Later, several specimens confirmed the presence of *Aquila heliaca* in France. Mayaud (1938) examined a juvenile collected in the Camargue in 1829 and preserved at the Nîmes Museum (NM). Also at NM we found another specimen, a juvenile also collected in the Camargue, 7 Apr 1931. In the Coimbra Museum we have seen an adult collected in France, without any date and precise locality. Lôche (1867) identified as *heliaca*

an adult eagle collected in Bayonne by Labarraque; according to Gurney (1877) this could be the same specimen reported by Jaubert & Barthelemy-Lappomeraye (1859). Sushkin (1901) examined an Eastern Imperial Eagle (not specifying its age) collected in Boulogne-sur-Mer. Glutz *et al.* (1971) referred to the capture of an adult in Môtigny (Yonne) in 1860, and Delmas (1912) named as *Aquila imperialis* another individual (without specifying its age) collected in Provence in 1898. L'Hermitte (1916) reported the capture of a juvenile *Aquila heliaca* (without indicating the species) in Comps (Var) in 1899 and the same author (L'Hermitte 1920) described a specimen, collected in 1920 at Marseille, and in transitional plumage as *heliaca*; but it is difficult to determine the species from his description.

Besides specimens, other evidence suggests the breeding of *Aquila heliaca* in France. One clutch of eggs from the Pyrenees (lacking the date of collection) and corresponding to "Imperial Eagle" (without specifying further) was found in the Bordeaux Museum. Companyo (1863), recorded *Falco imperialis* from Cerdaña, Cpacir and La Vall, noting it was becoming rare and mentioned some reproductive aspects. Dresser (1873) wrote: "In southern France, according to Jaubert & Barthelemy-Lappomeraye (1859) it has occurred several times; there appears to be no doubt the species is the present one—*Aquila heliaca*—and not the Spanish Imperial Eagle". Paris (1912) reported *Aquila heliaca* as an accidental inhabitant of the eastern Pyrenees and the upper Loire. Finally, Menegaux (1932) recorded the species as breeding on trees and cliffs in France, but only very occasionally.

Summarizing: we lack conclusive evidence of the breeding of the Eastern Imperial Eagle in France in the 19th century, but the sum of information strongly suggests it is likely. All the captured adult Imperial Eagles in France and most of the juveniles (see Gonzalez *et al.* in press) belonged to *Aquila heliaca*, as did most of those mentioned in the literature.

Italy

We have not found any references to the nesting of Imperial Eagles in Italy during and since the 19th century (Benoit 1840, Salvadori 1887, Giglioli 1889). Nine specimens have been reported (Perco 1969, Massa *et al.* 1979), all of them corresponding to *Aquila heliaca*. Eight were juveniles and one (collected in Savona on 10 Jan 1882) was an adult (Moltoni 1945).

Sushkin (1901) recorded the species as erratic in Italy. Bailly (1853) cited it as an inhabitant of Sardinia, but it seems that there are no details of observations nor of specimens (A. Mocci-Desmarte).

Switzerland

Degland & Gerbe (1867) reported the occasional presence of *Aquila heliaca* in the Alps. Fatio & Studer (1889) recorded a juvenile and an adult specimen collected in the Jura (both destined for the museums of Gêneve and Bonjour, according to the authors), another specimen (age not specified) in the Oberland of Bern and several observations in the regions of Friburg and Saint Gall.

Other European countries In the past century, the northwestern periphery of the breeding range of *Aquila heliaca* in Europe (Fig. 1) was Austria (Bauer & Rokitsky 1951), but with isolated breeding pairs in Germany (Luhder 1868) and Lithuania (Bree 1859), all of them countries where the species does not breed at present (Cramp & Simmons 1980). Glutz *et al.* (1971) reported one observation in 1842 on the island of Malta.

Algeria

For some authors (e.g. Heim de Balsac & Mayaud 1962, Glutz *et al.* 1971) the Algerian eagles were referred to *Aquila adalberti*, but most of the information from Algeria points to *Aquila heliaca*. Today the Imperial Eagle is extinct in Algeria (Ledant *et al.* 1981), but it bred there at least until the middle of the past century.

We know of 2 clutches in museums, one collected on Edough Mountain, Bona, in 1855 by Lôche (British Museum Natural History) (BMNH) and another collected in the Forest of Zeid, on 9 Apr 1857 (registered in the BMNH collection but found in Smithsonian Institution Nat. Hist. Museum collection). About this clutch, O. Salvin in his "1857, catalogue Algerian notebook for eggs", p. 6, wrote: "*Aquila Imperialis*. Is much rarer than the last [*Aquila fulvus*] as we were able to hear of only two eyries during the whole of our stay . . . two eggs in the nest, the nest was taken by La Tope and the next day visited by Tristram, who saw the birds about; he described the nest as being in a tree growing out of a rock near Kef Ouled Zeid . . .". Also, about the same event, Tristram (1860) wrote: ". . . had the satisfaction of watching a fine Imperial Eagle, who plainly exhibited the white feathers of the shoulder . . ., the two eggs which I obtained were hard set . . .".

Malherbe (1855), Tristram (*in* Bree 1859), Buvry (1857) and Homeyer (1863) also mention occurrences of Imperial Eagles in Algeria, but *Aquila adalberti* had not yet been described; *heliaca* is probably the more likely, since Lôche (1867), who was familiar with Imperial Eagles, attributed the skins of adult and juvenile specimens examined by himself to the Eastern population: ". . . [*Aquila heliaca*] peu commun en Algerie . . ., ne s'y reconte guere que dans les forets montagneuses . . . cet Aigle s'en distingue particulièrement par les plumes des scapulaires qui forment sur le manteau deux taches blanches et allongées . . .".

Other northwestern African countries

The only references to Imperial Eagles in Morocco correspond to *Aquila adalberti* (Irby 1895, Gonzalez *et al.* in press). We have not been able to find any data from Tunisia, either in the literature or in museum collections.

Discussion

The breeding of Imperial Eagles in northeastern Spain, southern France and Algeria in the 19th century has been proved. Conclusive evidence does not exist to confirm that these birds were Eastern Imperial Eagles *Aquila heliaca*, but the amount of circumstantial evidence strongly suggests it. In fact, neither clutches, skins of adult birds, nor references to



Figure 1. Ranges (shaded) during the 19th century of the Spanish and Eastern Imperial Eagle *Aquila heliaca/adalberti* in western and eastern Europe. Key of localities outside the shaded range Localities of skins of adults (●), non adults (○) and clutches (■) deposited in museum collections; and records of nests or adults in the breeding season (▲) and non-adults (△) from the literature and the authors' own data.

the breeding of *Aquila adalberti* in these regions have been found, while some data for *Aquila heliaca* do exist. Also, although most authors made no comment about the specific identity of Imperial Eagles from these countries, those which did so (e.g. Dresser 1873, in France and Lôche 1867, in Algeria) said they were Eastern Imperial Eagles.

If so, the breeding population of *Aquila heliaca* in western Europe could be partially migrant as in eastern Europe and Asia (Dementiev & Gladkov 1966, Cramp & Simmons 1980), making their way to Africa through continental Italy and Sicily to Cap Bon (Tunisia), as do other Central European raptors (Massa *et al.* 1979, Dejonghe 1980). This could explain the relatively important number collected along this route (Fig. 1). At present, this migrant breeding population has disappeared, but some wandering individuals, probably coming from eastern Europe, are observed from time to time (Cramp & Simmons 1980).

There seems hardly any doubt that the breeding ranges of the Eastern and the Spanish Imperial Eagles were in contact in the last century, and even more probably earlier still, at least in western Europe and probably in northern Africa. Such geographic contact (parapatry) would allow reproductive exchange and the possibility of hybrids. However, we have not detected a single specimen with intermediate plumage attributable to a hybrid in the 248 skins we have examined, and reference to hybrids does not appear at all in the literature. Failure to interbreed would indicate that previous reproductive isolation had led to species formation (Mayr 1969b, Bush 1975, Cracraft 1983), in which case, according to these last

authors, the present allopatry of these full species results from their ecological requirements being so similar that they compete and exclude each other mutually.

Because of the lack of conclusive proof, we cannot claim the recognition of *Aquila adalberti* as a distinct species only on the basis of the above evidence. However, the evidence adds support to the reasons previously advanced by several of the authors referred to earlier, and in our opinion the amount of circumstantial evidence suggesting the reproductive isolation of both Imperial Eagles justifies the recognition of *Aquila adalberti* as a full species.

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A new breeding record of the Izu Island Thrush *Turdus celaenops* from the Tokara Islands, southwest Japan

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The Izu Island Thrush *Turdus celaenops* is endemic to Japan, and has been known to breed only in the Izu Islands (Higuchi 1973, O.S.J. 1974). In the migration season it has been recorded as an accidental in the adjacent parts of Honshu main-island (e.g. Fujimura 1948, Hachisuka 1950). There are some specimens or sight records from remote islands, such as Yakushima Island (Ogawa 1905, Shirai 1956), Danjo Islands (W.B.S.J. 1978), and Tairajima Island (Kawaji *et al.* 1987), which are all off the Kyushu main-island; but the status of this thrush in such areas some 1000 km distant from the Izu Islands is not certain.

We observed 4-6 pairs in the 1988 breeding season in Nakanoshima Island (29°50'N, 129°48'E), 27.5 km² in area, and of the Tokara Islands, off Kyushu main-island (Fig. 1) and 2 nests were found there. This is the first record of the species breeding in an area other than the Izu Islands. In reporting here the breeding habits in Nakanoshima it is of interest to discuss the significance of this breeding record from the viewpoint of speciation.

The first nest was found on 12 May. The nesting site was 80 m above sea level. The habitat consisted mainly of *Persea thunbergii*, *Castanopsis sieboldii*, *Pleioblastus linearis*. The nest was placed 5.6 m above the ground in the forked branches of a deciduous tree *Mallotus japonicus*, which had a diameter at breast height (= DBH) of 14.0 cm. The nest was hemispherical in shape and the mouth opened upward. The inner diameter was 100 mm and the depth 62 mm. Nest materials were mainly pine leaves, moss, and twigs. We saw the female sitting on the nest on 13 May, but, unfortunately, the nest was found destroyed on 26 May.

The second nest was found on 21 June at 180 m a.s.l. It was amongst bamboos, *Pleioblastus linearis*, 2.5 m above the ground, and had been built by adding nest materials to a cluster of pine leaves caught on the bamboo twigs. The vegetation in the vicinity consisted mainly of *Pinus thunbergiana* and *P. linearis*. The measurements of the open nest were